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Nicasio Reservoir
Marin County, California

National Eutrophication Survey, Corvallis, Oreg

Prepared for

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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REPORT
ON
NICASIO RESERVOIR
MARIN COUNTY
CALIFORNIA
EPA REGION IX
WORKING PAPER No. 753

WITH THE COOPERATION OF THE
CALIFORNIA STATE WATER RESOURCES CONTROL BOARD
AND THE
CALIFORNIA NATIONAL GUARD
FEBRUARY, 1978

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentration (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the California State Water Resources Control Board and the nine Regional Water Quality Control Boards for professional involvement, to the California National Guard for conducting the tributary sampling phase of the Survey, and to those California wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

The staff of the Division of Planning and Research of the State Water Resources Control Board provided invaluable lake documentation and counsel during the Survey, coordinated the reviews of the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

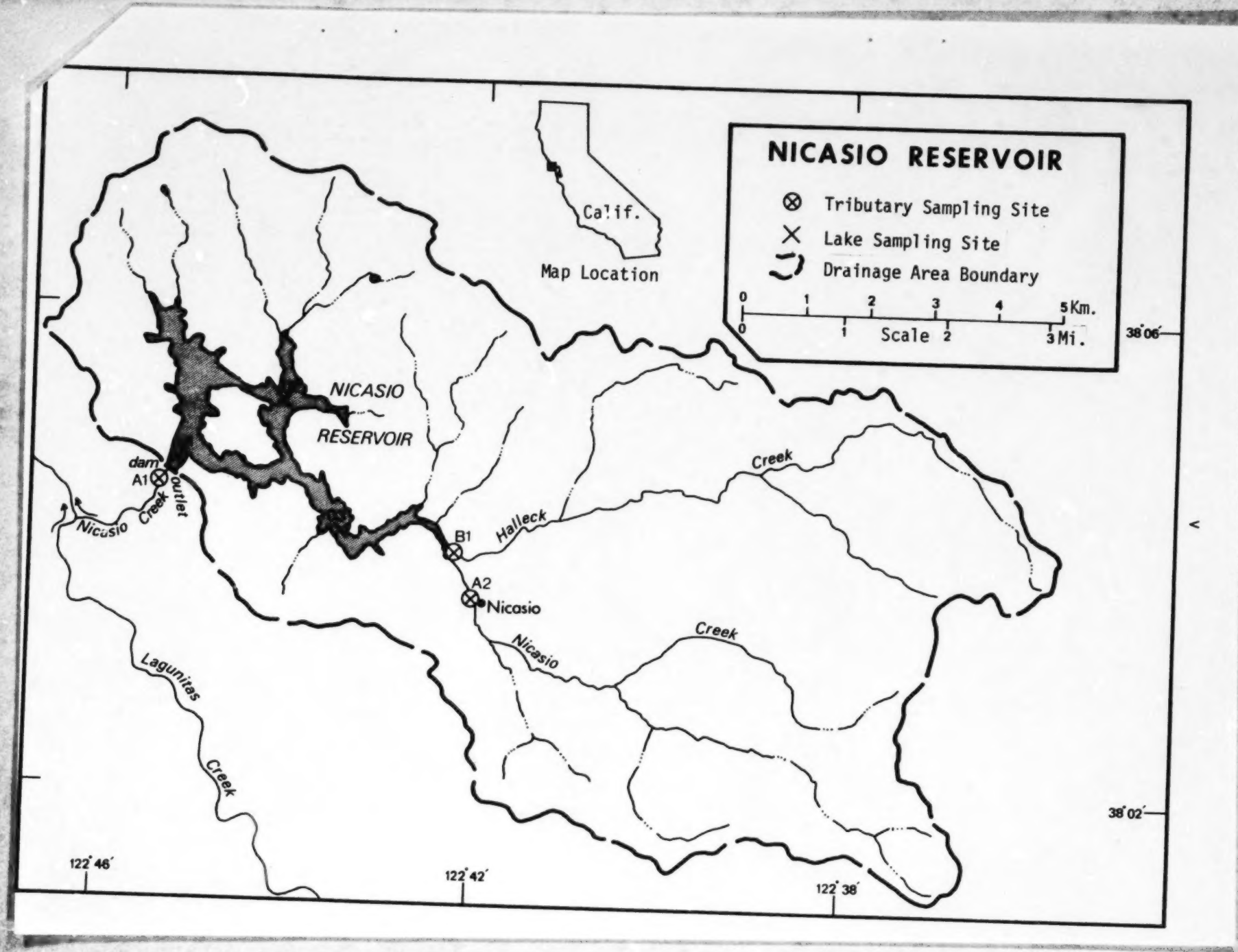
Major General Glen C. Ames, the Adjutant General of California, and Project Officer Second Lieutenant Terry L. Barrie, who directed the volunteer efforts of the California National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of California

Name	County
Amador	Amador
Boca	Nevada
Britton	Shasta
Casitas	Ventura
Crowley	Mono
Don Pedro	Tuolumne
Elsinore	Riverside
Fallen Leaf	El Dorado
Hennessey	Napa
Henshaw	San Diego
Iron Gate	Siskiyou
Lopez	San Luis Obispo
Mary	Mono
Mendocino	Mendocino
Nicasio	Marin
Lower Otay	San Diego
Pillsbury	Lake
Santa Margarita	San Luis Obispo
Shasta	Shasta
Shaver	Fresno
Silver	Mono
Tahoe	El Dorado, Placer, CA; Carson City, Douglas, Washoe, NV
Tulloch	Calaveras, Tuolumne
Lower Twin	Mono
Upper Twin	Mono


NICASIO RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
0 1 2 3 4 5 Km.
0 1 Scale 2 3 Mi.
Calif.
Map Location
NICASIO
RESERVOIR
dam
A1
outlet
Nicasio Creek
B1
Halleck Creek
A2
Nicasio
Nicasio Creek
Lagunitas Creek
38°06'
38°02'
122°46'
122°42'
122°38'

NICASIO RESERVOIR

STORET NO. 0617

I. CONCLUSIONS

A. Trophic Condition*:

Survey data indicate that Nicasio Reservoir is eutrophic. It ranked seventeenth in overall trophic quality among the 24 California lakes and reservoirs sampled in 1975 when compared using a combination of six water quality parameters**. Seventeen of the water bodies had less median total phosphorus, 12 had less and one had the same median dissolved orthophosphorus, 21 had less median inorganic nitrogen, 16 had less mean chlorophyll a, and 22 had greater mean Secchi disc transparency. No significant depression of dissolved oxygen occurred at any of the three stations during Survey sampling; however, artificial aeration has been used in the reservoir (Bailey, 1977).

Survey limnologists noted much suspended sediment during the sampling, and Secchi disc transparencies ranged from 0.3 to 0.6 meters. It is reported that phytoplankton and fish kills are problems in this water body (Johns, 1975), and copper sulfate has been applied for control of algae (Bailey, op. cit.).

B. Rate-Limiting Nutrient:

The algal assay results are not considered representative of conditions in the reservoir at the times the samples were taken due to significant changes in nutrients during shipment from the field to the laboratory. The reservoir data indicate

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* Trophic assessment is based on the levels of nutrients, dissolved oxygen, and chlorophyll a; phytoplankton kinds and numbers; and transparency (Allum et al., 1977).

** See Appendix A.

nitrogen limitation in March and November but phosphorus limitation in June. However, because of turbidity, primary productivity in the reservoir may be light-limited at times rather than nutrient-limited.

C. Nutrient Controllability:

1. Point sources--No known point sources impacted Nicasio Reservoir during the sampling year.

The sampling year phosphorus loading of 0.60 g/m^2 is a little less than that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 12). However, there was an apparent phosphorus loss during the sampling year which may have been due to underestimation of phosphorus input from the minor tributaries and immediate drainage (see below). Because of this, the calculated phosphorus loading probably is too low; e.g., if the total of the phosphorus inputs was a least equal to the amount leaving the reservoir, the areal loading would be 0.75 $g/m^2/yr$.

2. Non-point sources--Non-point sources accounted for all of the total phosphorus load during the sampling year. Nicasio Creek contributed 32.9%, Halleck Creek contributed 23.1%, and the ungaged minor tributaries and immediate drainage were estimated to have contributed 41.1% of the total.

Survey geographers indicate that much of the land (50%)

around the reservoir is cleared unproductive or rangeland. In addition, much of the terrain is steeply sloped. An additional investigation is needed to determine if both nutrient and sediment loads can be reduced by land-conservation measures.

II. RESERVOIR AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 3.42 kilometers^2.
2. Mean depth: 8.1 meters.
3. Maximum depth: 35.1 meters.
4. Volume: 27.754×10^6 m^3.
5. Mean hydraulic retention time: 256 days (based on outflow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Nicasio Creek	31.3	0.456
Halleck Creek	22.5	0.328
Minor tributaries & immediate drainage -	36.0	0.569
Totals	89.8	1.353

2. Outlet -

Nicasio Creek	93.2**	1.254**

C. Precipitation***:

1. Year of sampling: 49.9 centimeters.
2. Mean annual: 49.6 centimeters.

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† Table of metric conversions--Appendix B.
†† Dendy, 1974.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of reservoir; lesser outflow due to evaporation.
*** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Nicasio Reservoir was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at three stations on the reservoir (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first and last visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll *a* analysis. The maximum depths sampled were 24.4 meters at station 1, 8.5 meters at station 2, and 9.8 meters at station 3.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR NICASIO RESERVOIR
STORET CODE 0617

PARAMETER	1ST SAMPLING (3/13/75) 3 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (6/26/75) 3 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (11/11/75) 3 SITES RANGE	MEAN	MEDIAN
TEMP (C)	9.6 - 11.7	11.1	11.2	15.3 - 18.9	16.6	16.2	14.9 - 16.0	15.5	15.6
DISS OXY (MG/L)	7.6 - 11.0	9.1	9.2	5.2 - 10.4	7.1	7.0	8.2 - 9.2	8.7	8.6
CNDCTVY (MCROMO)	112. - 121.	114.	114.	135. - 155.	142.	140.	165. - 171.	169.	169.
PH (STAND UNITS)	7.5 - 7.8	7.6	7.6	7.5 - 8.1	7.8	7.7	7.7 - 8.1	7.8	7.8
TOT ALK (MG/L)	57. - 68.	62.	61.	63. - 70.	68.	68.	60. - 75.	69.	70.
TOT P (MG/L)	0.068 - 0.123	0.093	0.096	0.038 - 0.088	0.053	0.048	0.036 - 0.059	0.048	0.049
ORTHO P (MG/L)	0.034 - 0.058	0.048	0.048	0.006 - 0.014	0.011	0.011	0.008 - 0.014	0.010	0.010
NO2+NO3 (MG/L)	0.440 - 0.560	0.517	0.520	0.110 - 0.350	0.236	0.235	0.020 - 0.040	0.028	0.020
AMMONIA (MG/L)	0.030 - 0.060	0.041	0.040	0.040 - 0.100	0.054	0.050	0.020 - 0.030	0.021	0.020
KJEL N (MG/L)	0.300 - 0.800.	0.493	0.500	0.200 - 0.500	0.386	0.400	0.200 - 0.600	0.318	0.300
INORG N (MG/L)	0.500 - 0.600	0.558	0.560	0.160 - 0.400	0.290	0.305	0.040 - 0.060	0.049	0.050
TOTAL N (MG/L)	0.850 - 1.300	1.011	0.960	0.410 - 0.820	0.622	0.575	0.240 - 0.620	0.346	0.320
CHLRPYL A (UG/L)	2.0 - 6.4	4.1	3.8	4.2 - 7.1	6.1	6.9	6.6 - 14.0	9.8	8.7
SECCHI (METERS)	0.3 - 0.3	0.3	0.3	0.6 - 0.6	0.6	0.6	0.4 - 0.5	0.4	0.4

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/13/75	1. Cryptomonas sp.	362
	2. Chroomonas (?) sp.	226
	3. Stephanodiscus sp.	90
	Total	678
03/26/75	1. Stephanodiscus sp.	3,156
	2. Chroomonas (?) sp.	298
	3. Aphanizomenon sp.	149
	4. Crucigenia sp.	124
	5. Aphanocapsa sp.	99
	Other genera	250
	Total	4,076
11/11/75	1. Cryptomonas sp.	297
	2. Pediastrum sp.	132
	3. Asterionella sp.	99
	4. Pediastrum sp.	99
	5. Melosira sp.	66
	Other genera	99
	Total	792

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
03/13/75	1	2.0
	2	3.8
	3	6.4
06/26/75	1	4.2
	2	7.1
	3	6.9
11/11/75	1	8.7
	2	14.0
	3	6.6

C. Limiting Nutrient Study:

Due to significant changes in the nutrients in the samples during shipment from the field to the laboratory, the algal assay results are not considered representative of conditions in the reservoir at the times the samples were collected (03/13/75 and 11/11/75).

The reservoir data indicate nitrogen limitation in March and November but phosphorus limitation in June; i.e., the mean inorganic nitrogen/orthophosphorus ratios were 12/1 or less at all stations in March and November but 24/1 or greater at all stations in June.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the California National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of February, March, and April when two samples were collected. Sampling was begun in November, 1974, and was completed in October, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the California District Office of the U.S. Geological Survey for the tributary sites nearest the reservoir.

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in Nicasio and Halleck creeks at stations A-2 and B-1 and the mean annual ZZ flow.

No known wastewater treatment plants impacted the reservoir during the sampling year.

A. Waste Sources:

1. Known municipal - None
2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Nicasio Creek	675	32.9
Halleck Creek	475	23.1
b. Minor tributaries & immediate drainage (non-point load) -	845	41.1
c. Known municipal STP's - None	-	-
d. Septic tanks - Unknown	?	-
e. Known industrial - None	-	-
f. Direct precipitation* -	60	2.9
Total	2,055	100.0

2. Outputs -

Reservoir outlet - Nicasio Creek 2,575

3. Net annual P loss - 520 kg.

* See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Nicasio Creek	21,195	30.1
Halleck Creek	17,420	24.7
b. Minor tributaries & immediate drainage (non-point load) -	28,135	40.0
c. Known municipal STP's - None	-	-
d. Septic tanks - Unknown	?	-
e. Known industrial - None	-	-
f. Direct precipitation* -	3,690	5.2
Total	70,440	100.0

2. Outputs -

Reservoir outlet - Nicasio Creek 68,470

3. Net annual N accumulation - 1,970 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Nicasio Creek	22	677
Halleck Creek	21	774

* See Working Paper No. 175.

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.60	loss*	20.6	0.6

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Nicasio Reservoir:

"Dangerous" (eutrophic loading)	0.64
"Permissible" (oligotrophic loading)	0.32

* There was an apparent loss of phosphorus during the sampling year. This may be indicative of unknown point sources discharging directly to the reservoir, recharge with phosphorus-rich ground water, resolubilization of previously sedimented phosphorus, or (probably) underestimation of the phosphorus load from the minor tributaries and immediate drainage.

V. LITERATURE REVIEWED

Allum, M. O., R. E. Glessner, and J. H. Gakstatter, 1977. An evaluation of the National Eutrophication Survey data. Working Paper No. 900, Corvallis Env. Res. Lab., Corvallis, OR.

Bailey, Thomas E., 1977. Personal communication (reviews of preliminary reports). CA Water Res. Contr. Bd., Sacramento.

Dendy, William B., 1974. Personal communication (reservoir information and morphometry). CA Water Res. Contr. Bd., Sacramento.

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Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
0601	AMADOR RESERVOIR	0.040	0.390	408.667	22.383	14.600	0.020
0602	BOCA LAKE	0.012	0.040	372.833	1.700	6.800	0.003
0603	LAKE BRITTON	0.067	0.115	448.500	4.811	11.200	0.047
0604	CASITAS RESERVOIR	0.029	0.050	400.250	3.192	14.000	0.014
0605	CROWLEY LAKE	0.046	0.045	374.750	5.800	12.200	0.034
0606	DON PEDRO RESERVOIR	0.013	0.060	381.733	3.564	11.400	0.004
0607	LAKE ELSINORE	0.469	0.120	489.214	70.572	8.000	0.092
0608	FALLEN LEAF RESERVOIR	0.007	0.040	24.357	0.786	8.800	0.005
0609	LAKE HENNESSEY	0.027	0.060	416.000	4.525	15.000	0.012
0610	LAKE HENSHAW	0.138	0.070	461.000	26.783	9.800	0.073
0611	IRON GATE RESERVOIR	0.184	0.690	440.333	6.217	13.800	0.124
0614	LOPEZ LAKE	0.371	0.090	372.000	8.658	15.000	0.343
0615	LAKE MARY	0.010	0.040	296.000	2.550	10.600	0.002
0616	LAKE MENDOCINO	0.020	0.050	436.500	3.100	9.400	0.008
0617	NICASIO RESERVOIR	0.055	0.345	482.778	6.633	9.800	0.013
0618	LOWER OTAY RESERVOIR	0.058	0.180	447.250	15.933	15.000	0.013
0619	LAKE PILLSBURY	0.022	0.060	466.667	6.389	8.200	0.008
0620	SANTA MARGARITA LAKE	0.037	0.070	400.000	9.122	14.800	0.014
0621	SHASTA LAKE	0.021	0.060	381.542	4.087	9.000	0.015
0622	SHAVER	0.014	0.060	346.400	1.700	7.400	0.004
0623	SILVER LAKE	0.012	0.055	356.000	1.800	7.000	0.003
0624	TULLOCK RESERVOIR	0.025	0.060	433.000	13.878	7.400	0.009
0625	UPPER TWIN LAKES	0.015	0.040	300.200	3.340	7.400	0.004
0626	LOWER TWIN LAKES	0.014	0.040	248.000	2.900	11.400	0.003

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
0601	AMADOR RESERVOIR	35 (8)	4 (1)	43 (10)	9 (2)	17 (4)	26 (6)	134
0602	BOCA LAKE	89 (20)	98 (22)	70 (16)	91 (21)	100 (23)	91 (20)	539
0603	LAKE BRITTON	17 (4)	22 (5)	17 (4)	48 (11)	43 (10)	17 (4)	164
0604	CASITAS RESERVOIR	43 (10)	74 (17)	48 (11)	70 (16)	22 (5)	37 (8)	294
0605	CROWLEY LAKE	30 (7)	78 (18)	65 (15)	43 (10)	30 (7)	22 (5)	268
0606	DON PEDRO RESERVOIR	83 (19)	54 (11)	57 (13)	61 (14)	37 (8)	78 (17)	370
0607	LAKE ELSINORE	0 (0)	17 (4)	0 (0)	0 (0)	78 (18)	9 (2)	104
0608	FALLEN LEAF RESERVOIR	100 (23)	87 (19)	100 (23)	100 (23)	70 (16)	70 (16)	527
0609	LAKE HENNESSEY	48 (11)	54 (11)	39 (9)	52 (12)	4 (0)	52 (12)	249
0610	LAKE HENSHAW	13 (3)	33 (7)	13 (3)	4 (1)	54 (12)	13 (3)	130
0611	IRON GATE RESERVOIR	9 (2)	0 (0)	26 (6)	39 (9)	26 (6)	4 (1)	104
0614	LOPEZ LAKE	4 (1)	26 (6)	74 (17)	26 (6)	4 (0)	0 (0)	134
0615	LAKE MARY	96 (22)	87 (19)	91 (21)	83 (19)	48 (11)	100 (23)	505
0616	LAKE MENDOCINO	65 (15)	70 (16)	30 (7)	74 (17)	61 (14)	63 (14)	363
0617	NICASIO RESERVOIR	26 (6)	9 (2)	4 (1)	30 (7)	54 (12)	46 (10)	169
0618	LOWER OTAY RESERVOIR	22 (5)	13 (3)	22 (5)	13 (3)	4 (0)	46 (10)	120
0619	LAKE PILLSBURY	57 (13)	41 (9)	9 (2)	35 (8)	74 (17)	63 (14)	279
0620	SANTA MARGARITA LAKE	39 (9)	33 (7)	52 (12)	22 (5)	13 (3)	37 (8)	196
0621	SHASTA LAKE	61 (14)	54 (11)	61 (14)	57 (13)	65 (15)	30 (7)	328
0622	SHAVER	78 (18)	41 (9)	83 (19)	96 (22)	87 (19)	78 (17)	463
0623	SILVER LAKE	89 (20)	65 (15)	78 (18)	87 (20)	96 (22)	91 (20)	506
0624	TULLOCK RESERVOIR	52 (12)	54 (11)	35 (8)	17 (4)	87 (19)	57 (13)	302
0625	UPPER TWIN LAKES	70 (16)	98 (22)	87 (20)	65 (15)	87 (19)	78 (17)	485
0626	LOWER TWIN LAKES	74 (17)	87 (19)	96 (22)	78 (18)	37 (8)	91 (20)	463

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	0602	BOCA LAKE	539
2	0608	FALLEN LEAF RESERVOIR	527
3	0623	SILVER LAKE	506
4	0615	LAKE MARY	505
5	0625	UPPER TWIN LAKES	485
6	0626	LOWER TWIN LAKES	463
7	0622	SHAVER	463
8	0606	DON PEDRO RESERVOIR	370
9	0616	LAKE MENDOCINO	363
10	0621	SHASTA LAKE	328
11	0624	TULLOCK RESERVOIR	302
12	0604	CASITAS RESERVOIR	294
13	0619	LAKE PILLSBURY	279
14	0605	CROWLEY LAKE	268
15	0609	LAKE HENNESSEY	249
16	0620	SANTA MARGARITA LAKE	196
17	0617	NICASIO RESERVOIR	169
18	0603	LAKE BRITTON	164
19	0614	LOPEZ LAKE	134
20	0601	AMADOR RESERVOIR	134
21	0610	LAKE HENSHAW	130
22	0618	LOWER OTAY RESERVOIR	120
23	0607	LAKE ELSINORE	104
24	0611	IRON GATE RESERVOIR	104

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR CALIFORNIA 12/02/76

LAKE CODE 0617 NICASIO RESERVOIR

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 93.2

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
0617A1	93.2	7.354	3.259	2.256	0.919	0.050	0.008	0.033	0.050	0.063	0.059	0.109	0.961	1.254
0617A2	31.3	2.121	1.091	0.606	0.242	0.039	0.021	0.009	0.0	0.0	0.091	0.364	0.909	0.456
0617B1	22.5	1.545	0.788	0.424	0.182	0.030	0.015	0.006	0.0	0.0	0.061	0.273	0.636	0.328
0617ZZ	93.2	2.657	1.372	0.730	0.321	0.050	0.023	0.015	0.0	0.0	0.117	0.467	1.109	0.569

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 93.2
SUM OF SUB-DRAINAGE AREAS = 147.1

TOTAL FLOW IN = 16.31
TOTAL FLOW OUT = 15.12

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
0617A1	11	74	0.028	16	0.008				
	12	74	0.008	7	0.008				
	1	75	0.008	4	0.008				
	2	75	0.008	1	0.008	15	0.008		
	3	75	4.842	1	0.008	15	1.699	29	2.265
	4	75	0.238	12	0.085	26	0.057		
	5	75	0.008	17	0.008				
	6	75	0.031	7	0.031				
	7	75	0.037	12	0.037				
	8	75	0.068	2	0.068				
	9	75	0.068	6	0.068				
	10	75	0.017	18	0.017				
0617A2	11	74	0.0	16	0.0				
	12	74	0.028	7	0.003				
	1	75	0.110	4	0.040				
	2	75	2.718	1	1.218	15	1.897		
	3	75	1.784	1	0.340	15	0.595	29	0.793
	4	75	0.246	12	0.278	26	0.167		
	5	75	0.037	17	0.020				
	6	75	0.008	7	0.006				
	7	75	0.0	12	0.0				
	8	75	0.0	2	0.0				
	9	75	0.0	6	0.0				
	10	75	0.003	18	0.0				

TRIBUTARY FLOW INFORMATION FOR CALIFORNIA 12/02/76

LAKE CODE 0617 NICASIO RESERVOIR

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
061781	11	74	0.0	16	0.0				
	12	74	0.017	7	0.003				
	1	75	0.079	4	0.028				
	2	75	1.954	1	0.538	15	1.359		
	3	75	1.274	1	0.252	15	0.425	29	0.566
	4	75	0.176	12	0.198	26	0.119		
	5	75	0.025	17	0.014				
	6	75	0.006	7	0.006				
	7	75	0.0	12	0.0				
	8	75	0.0	2	0.0				
	9	75	0.0	6	0.0				
	10	75	0.003	18	0.0				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/09/24

061701
38 04 39.0 122 45 10.0 3
NICASIO RESERVOIR
06041 CALIFORNIA

140391

11EPALES 2111202
0084 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/03/13	10 00	0000	10.9	9.2	12	114	7.80	62	0.040	0.600	0.510	0.054
	10 00	0005	10.9	9.2		113	7.70	60	0.030	0.400	0.530	0.051
	10 00	0015	10.9	9.4		114	7.70	60	0.030	0.400	0.540	0.041
	10 00	0030	10.8	9.0		114	7.70	59	0.030	0.400	0.540	0.034
	10 00	0045	10.7	8.8		114	7.60	60	0.030	0.400	0.540	0.040
	10 00	0060	10.0	8.2		114	7.50	61	0.030	0.300	0.550	0.048
	10 00	0080	9.6	7.6		121	7.50	65	0.040	0.400	0.560	0.048
75/06/26	13 20	0000	16.6	7.0	24	140	7.90	69	0.060	0.500	0.260	0.011
	13 20	0005	15.9	7.4		140	7.80	68	0.040	0.500	0.300	0.011
	13 20	0015	15.8	7.0		140	7.70	67	0.040	0.500	0.310	0.011
	13 20	0035	15.7	6.8		140	7.70	68	0.040	0.500	0.320	0.014
	13 20	0055	15.6	6.6		135	7.60	69	0.040	0.500	0.320	0.013
	13 20	0074	15.3	5.2		135	7.55	68	0.050	0.200K	0.350	0.013
75/11/11	12 00	0000	16.0	9.0	18	171	7.75	74	0.020	0.300	0.030	0.009
	12 00	0005	16.0	8.6		171	7.70	75	0.020	0.200	0.040	0.011
	12 00	0015	15.9	8.6		171	7.70	74	0.020	0.200	0.040	0.010
	12 00	0035	16.0	8.4		171	7.70	72	0.020	0.200	0.040	0.014
	12 00	0055	15.9	8.2		171	7.70	70	0.020	0.200	0.040	0.010

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/03/13	10 00	0000	0.084	2.0	
	10 00	0005	0.076		
	10 00	0015	0.076		
	10 00	0030	0.074		
	10 00	0045	0.068		
	10 00	0060	0.073		
	10 00	0080	0.081		
75/06/26	13 20	0000	0.045	4.2	
	13 20	0005	0.048		
	13 20	0015	0.046		
	13 20	0035	0.052		
	13 20	0055	0.052		
	13 20	0074	0.088		
75/11/11	12 00	0000	0.036	8.7	
	12 00	0005	0.036		
	12 00	0015	0.051		
	12 00	0035	0.050		
	12 00	0055	0.044		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/09/24

061702
38 05 17.0 122 43 55.0 3
NICASIO RESERVOIR
06041 CALIFORNIA

140391

11EPALES 2111202
0030 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/03/13	10 50	0000	11.6	9.4	12	112	7.65	60	0.050	0.700	0.520	0.053
	10 50	0005	11.6	9.4		112	7.70	57	0.050	0.500	0.510	0.055
	10 50	0015	11.4	11.0		112	7.60	60	0.040	0.400	0.520	0.047
	10 50	0026	11.2	9.0		113	7.60	63	0.040	0.500	0.520	0.041
75/06/26	13 50	0000	17.2	7.0	24	140	8.00	70	0.040	0.400	0.190	0.006
	13 50	0005	17.2	8.4		145	8.00	63	0.050	0.400	0.160	0.014
	13 50	0015	17.2	8.0		145	7.70	65	0.060	0.300	0.170	0.008
	13 50	0028	15.9	6.6		145	7.60	70	0.100	0.300	0.190	
75/11/11	12 30	0000	15.6	9.2	15	165	7.90	67	0.020K	0.300	0.020K	0.010
	12 30	0005	15.0	8.8		166	7.85	66	0.020K	0.300	0.020K	0.009
	12 30	0010	15.0	8.8		165	7.85	65	0.020K	0.300	0.020K	0.009

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/03/13	10 50	0000	0.098	3.8	
	10 50	0005	0.096		
	10 50	0015	0.103		
	10 50	0026	0.107		
75/06/26	13 50	0000	0.038	7.1	
	13 50	0005	0.044		
	13 50	0015	0.055		
75/11/11	12 30	0000	0.052	14.0	
	12 30	0005	0.049		
	12 30	0010	0.045		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/09/24

061703
38 04 12.0 122 43 27.0 3
NICASIO RESERVOIR
06041 CALIFORNIA

140391

11EPALES 2111202
0036 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/03/13	11 25	0000	11.7	9.2	11	113	7.00	63	0.060	0.800	0.500	0.048
	11 25	0005	11.7	9.2		114	7.65	63	0.040	0.600	0.490	0.058
	11 25	0015	11.7	9.2		114	7.60	64	0.040	0.500	0.490	0.055
	11 25	0032	11.3	9.2		118	7.60	68	0.060	0.500	0.440	0.043
75/06/26	14 15	0000	18.9	7.8	24	155	8.15	68	0.050	0.300	0.110	0.006
	14 15	0005	18.2	10.4		150	8.10	69	0.050	0.400	0.130	0.010
	14 15	0015	16.7	6.0		140	7.70	67	0.060	0.300	0.210	0.010
	14 15	0029	15.9	5.8		140	7.60	67	0.070	0.300	0.290	0.012
75/11/11	12 45	0000	15.1	9.2	15	169	8.10	70	0.020K	0.500	0.020K	0.011
	12 45	0005	15.1	8.6		167	7.90	60	0.020	0.600	0.020K	0.010
	12 45	0015	14.9	8.6		169	7.80	62	0.030	0.400	0.020K	0.008

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/03/13	11 25	0000	0.115	6.4	
	11 25	0005	0.123		
	11 25	0015	0.112		
	11 25	0032	0.107		
75/06/26	14 15	0000	0.048	6.9	
	14 15	0005	0.050		
	14 15	0015	0.048		
	14 15	0029	0.069		
75/11/11	12 45	0000		6.6	
	12 45	0005	0.055		
	12 45	0015	0.059		

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/09/24

0617A1
38 04 25.0 122 45 20.0 4
NICASIO CREEK
06 7.5 INVERNESS
O/NICASIO RESERVOIR 140391
BNK 50 FT E SEC RD .1 MI BELO DAM
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/16	10	05	0.256	2.300	0.060	0.015	0.050
74/12/07	09	36	0.272		0.040	0.010	0.040
75/01/04	09	35	0.304	2.400	0.016	0.007	0.030
75/02/01	09	55	0.184	0.946	0.032	0.010	0.070
75/02/15	08	40	0.704	3.200	0.048	0.016	0.060
75/03/01	08	30	0.480	1.200	0.016	0.040	0.070
75/03/15	10	00	0.464	0.600	0.008	0.040	0.080
75/03/29	10	15	0.436	1.800	0.018	0.049	0.110
75/04/12	08	30	0.390	1.150	0.020	0.040	0.060
75/04/26	08	30	0.360	0.900	0.025	0.035	0.070
75/05/17	10	15	0.005	2.900	0.020	0.010	
75/06/07	09	45	0.350	0.800	0.045	0.020	0.060
75/07/12	09	45	0.290	0.800	0.015	0.015	0.090
75/08/02	09	45	0.290	0.550	0.020	0.015	0.060
75/09/06	09	00	0.160	1.100	0.035	0.015	0.060
75/10/18	09	00	0.035	0.600	0.010	0.005K	0.060

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/09/24

0617A2
38 03 45.0 122 41 55.0 4
NICASIO CREEK
06 7.5 SAN GERONIMO
T/NICASIO RESERVOIR 140391
UNPVD RD BRDG .1 MI NW OF NICASIO
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/15	09	30	0.168	1.600	0.030	0.025	0.030
74/12/07	09	51	0.168	1.500	0.025	0.015	0.030
75/01/04	09	50	0.920	2.800	0.060	0.020	0.020
75/02/01	10	10	0.660	1.150	0.024	0.030	0.130
75/02/15	08	55	0.400	1.700	0.032	0.024	0.060
75/03/01	08	45	0.464	0.300	0.008	0.024	0.030
75/03/15	10	30	0.240	0.300	0.008K	0.024	0.030
75/03/29	09	45	0.222	1.000	0.009	0.024	0.030
75/04/26	09	00	0.100	0.450	0.015	0.015	0.030
75/05/17	10	38	0.145	1.400	0.035	0.015	0.080
75/06/07	10	00	0.060	0.550	0.025	0.010	0.010
75/07/12	10	15	0.120	2.500	0.040	0.015	0.030
75/08/02	09	00	0.145	0.500	0.010	0.025	0.030
75/09/06	09	15	0.210	1.900	0.025	0.130	0.130
75/10/18	09	15	0.145	0.300	0.015	0.025	0.040

K VALUE KNOWN TO BE
LESS THAN INDICATED

29

STORET RETRIEVAL DATE 76/09/24

061781
38 04 05.0 122 42 05.0 4
HALLECK CREEK
06 7.5 SAN GERONIMO
T/NICASIO RESERVOIR 140391
SEC RD BRDG .4 MI NW OF NICASIO
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/12/07	09 56		0.528	0.800	0.025	0.025	0.040
75/01/04	10 00		0.780	2.100	0.045	0.015	0.020
75/02/01	10 30		0.990	1.000	0.032	0.040	0.130
75/02/15	09 00		0.640	1.500	0.032	0.024	0.080
75/03/01	08 55		0.600	0.700	0.008	0.016	0.020
75/03/15	10 45		0.320	0.500	0.008K	0.016	0.030
75/03/29	10 00		0.317	0.750	0.024	0.018	0.030
75/04/12	09 00		0.165	0.750	0.015	0.015	0.015
75/04/26	09 15		0.130	1.150	0.015	0.015	
75/05/17	10 45		0.125	2.300	0.022	0.035	
75/06/07	10 10		0.035	0.500	0.025	0.020	0.020
75/07/12	10 20		0.030	3.500	0.045	0.035	0.080

K VALUE KNOWN TO BE
LESS THAN INDICATED